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Magnetic Stars with Wide Depressions in the Continuum. 2. The Silicon Star with a Complex Field Structure HD 27404

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Abstract—Observations of the chemically peculiar star HD 27404 with the 6-m SAO RAS telescope showed a strong magnetic field with the longitudinal field component varying in a complicated way in the range of −2.5 to 1 kG. Fundamental parameters of the star ($T_{\rm eff} = 11\,300$ K, $\log g = 3.9$) were estimated analyzing photometric indices in the Geneva and in the Strömgren–Crawford photometric systems. We detected weak radial velocity variations which can be due to the presence of a close star companion or chemical spots in the photosphere. Rapid estimation of the key chemical element abundance allows us to refer HD 27404 to a SiCr or Si+ chemically peculiar A0–B9 star.

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1. INTRODUCTION

In physics, stellar atmospheres can be viewed as natural laboratories. Variety of physical conditions makes it possible to study general laws in structures of stellar atmosphere and their evolution. Stellar magnetism is of special interest for studies, as the nature of processes ongoing in such objects can be determined by significant influence of a magnetic field. The strongest magnetic fields up to tens of kilogauss are found in non-degenerate objects in the upper region of the Main Sequence. Here, in the region of effective temperatures of 6500–25 000 K along with a great number of stars with normal (close to the solar-type) chemical abundance, there are 10–15% of stars with signs of an over- or under-abundance of certain chemical elements in the photosphere. Following the usual terminology, such stars are called chemically peculiar, or CP stars [1, 2]. In turn, a number of them refer to a group of so-called "magnetic" (mCP) stars. Key feature of these objects is the presence of global, strong and stable over years and decades magnetic fields. Due to hard work of many teams, the number of known mCP stars has been increased up to 500 which is about 1% of all stars in the same effective temperature range. Convenience of studying magnetism using observations of CP stars is in the possibility to create the control sample from "normal"—non-magnetic stars. However, in many cases due to the observed scatter in physical parameters of CP stars, the size of samples by certain criteria, e.g., by chemical anomaly types or rotation periods, is still insufficient for reliable statistical inferences. Thus, our task is to expand the sample of known magnetic stars.

To improve the search efficiency, it is possible to identify the characteristic features of mCP stars which ideally would be accessible for quantitative measurement with methods simpler than spectropolarimetry: for example, using photometry or low-resolution spectroscopy. In such a case, it becomes possible to select a large number of the most probable candidate stars for further investigation at large telescopes, the observation time at which is always limited. One of the pre-selection criteria is based on flux depressions (regions with abnormally high absorption) in the CP star continuous spectra. The most noticeable depression centered 5200 Å is quantitatively described by the Z index in the Geneva photometric system and by the Δa index in the Vienna one. In paper [3], we have shown that there is a strong correlation between the magnitude of a magnetic field on a stellar surface and the depth of 5200 Åflux depression. Using this fact, we observed 96 mCP candidate stars with strong depressions with the 6-m BTA telescope of the Special Astrophysical Observatory of the Russian Academy of Sciences and

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